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Enteroatmospheric fistulae in open abdomen: Management and outcome – Single center experience

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ABSTRACT

Background: An enteroatmospheric fistula (EAF) is a known, morbid complication of open abdomen (OA) treatment. Patients with EAF often require repeated operations and long-lasting hospitalization. The goal is to reach prompt closure of both the fistula and the OA to avoid further morbidity and mortality. This study describes and analyzes the treatment of EAFs in our clinic and aims at clarifying the factors contributing to the outcome.

Materials and Methods: This study was carried out as a single-institution retrospective chart analysis of patients treated with an OA and EAF at our institute between years 2004 and 2014. Twenty-six patients were included in the analysis.

Results: Twenty-three (88%) of the EAFs were primarily managed surgically: 14 with suturing and 9 with resection and/or stoma. From the latter group two died 1 and 2 days, respectively, after surgery. Of the remaining 21 patients, EAF recurred in 12/14 (86%) patients after suturing whereas in only 3/7 (43%) patients after resection and/or stoma ($p = 0.04$). Among the 21 early survivors after EAF repair, four patients reached fascial closure simultaneously with the EAF repair. Of the rest 9/17 had Bogota bag or drapes as temporary abdominal closure and 8/17 were treated with vacuum assisted closure device with or without fascial traction by mesh. All the nine patients treated with non-negative pressure dressings developed recurrence but only 4/8 in the negative-pressure treated group ($p < 0.02$). All conservatively treated patients developed persistent EAF. The overall in-hospital mortality rate was 35% (9/26).

Conclusion: Surgical repair of EAF has a high failure rate. Primary resection of the affected region appears to be the most successful approach to avoid EAF recurrence. Furthermore, negative pressure wound therapy is superior to non-negative-pressure solutions in relation to EAF recurrence.

1. Introduction

Open abdomen (OA) is an efficient means to treat and follow up critically ill patients with abdominal hypertension (IAH) or abdominal compartment syndrome (ACS) [1–3]. The goal is to reach prompt primary fascial closure, for the longer the OA treatment, the more common are the complications [4,5]. The well-known problem with prolonged OA is the development of adhesions, scarring, lateralization of the abdominal wall and finally frozen abdomen [6]. This course of events predisposes also to the development of enteroatmospheric fistulae (EAF), which are considered as parts of this vicious circle. The Classification of Open Abdomen [7] was designed to improve the management of patients with OA and it describes these phenomena in detail.

The factors predisposing to the development of EAFs are not clear. There are a few studies attaching abdominal sepsis to a higher incidence of EAFs [8,9]. In trauma patients treated with OA the incidence of EAFs has been associated with large-volume resuscitation and an increasing number of re-explorations [10]. Negative pressure wound therapy (NPWT), also used to treat an EAF, is linked to their development in 5% of patients [11]. Earlier reports have revealed the incidence of EAFs to approximate 20% during NPWT [12,13]. The etiology of an EAF may often be multifactorial and represent a combination of several independent factors including the primary diagnosis and cause for OA treatment, iatrogenic lesions of the intestinal tract during laparostomy/relaparotomy, postoperative anastomotic rupture, dehydration, swelling and ischemia of the intestine, exposure of the bowel to materials used for temporary abdominal closure (TAC), adhesions between the bowel and the abdominal wall, wound infections [11]. In line with these data, the

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incidence of EAFs has been described to be highest among patients with abdominal sepsis and pancreatic necrosis [14,15]. Overall the incidence of EAFs varies between 5 and 75% in OA patients [16].

The aim of this study was to assemble and analyze the patients treated for OA and EAF in our clinic. We describe the management of these patients and aim at clarifying possible factors predicting the outcome.

2. Material and methods

This study was carried out as a single institution retrospective chart analysis of patients treated with an open abdomen and enteroatmospheric fistulae at our institute between years 2004 and 2014. The inclusion criterion was diagnosis of an EAF within the studied time period. Exclusion criteria were other existing enterocutaneous fistulae and tumor fistulae. Altogether 229 patients were treated for open abdomen during this time interval. Thirty patients met the inclusion criteria. Three of these were either pre- or postoperatively treated in another hospital and had thus incomplete records and were excluded from the analysis. One trauma patient was hospitalized for over two years and had altogether 150 operations of which several had extra-abdominal targets. This patient was excluded due to impalpable and rambling data.

2.1. OA classification

The open abdomen was characterized at the first diagnosis of an EAF. The amended classification system of the open abdomen was used [17]. Briefly, the status of open abdomen is divided into four classes according to the stage of fixation (1 to 3) and contamination (A to C). Number 4 represents established EAF in a frozen abdomen.

2.2. Temporary abdominal closure (TAC)

Vacuum and mesh mediated fascial traction (VACM) was used for 13 patients as TAC prior to the EAF diagnosis. The other half (13 patients) had either Bogota bag or surgical drapes to temporarily seal the abdomen.

VACM methodology has been previously described by Petersson et al. in 2007 [18] and we have reported it to result in high fascial closure rate after OA [19]. In brief, the commercially available VAC system (V.A.C.® Abdominal dressing system, KCI, San Antonio, Texas; USA) was used. First, the intra-abdominal contents were covered by a polyethylene sheet. An oval-shaped polypropylene mesh was then sutured to the fascial edges and covered with a polyurethane sponge and finally with occlusive sheets. This system was then connected to a suction apparatus creating continuous topical negative pressure (125 mmHg).

TAC changes were performed every two to three days in the operating theater or bedside at the intensive care unit. For VACM patients, the mesh was divided in midline at the first TAC change and then tightened with continuous suturing after replacing the inner polyethylene sheet with a sterile one.

2.3. Method of EAF repair

In cases of twenty-three patients, all the diagnosed EAFs were primarily managed operatively. The methods were direct suturing of the opening of the fistula with absorbable 4/0 or 3/0 sutures, resection of the affected bowel loop and/or preparation of a stoma. Three patients were treated conservatively for their EAFs. One was primarily managed with an intraluminally inserted percutaneous gastrostoma system (PEG) and two were merely followed up because of minimal leakage.

2.4. Statistical analysis

Statistical analyses were performed using IBM® SPSS® Statistics version 19 for Windows® (Armonk, New York, USA). Fisher's exact test was used for comparison of subgroups.

3. Results

3.1. Patient characteristics

Twenty-six patients treated with OA and EAF were included in the analysis. The detailed patient characteristics are described in Tables A.1 and A.2. Twenty-five (96%) patients represented with at least one chronic illness. Eighteen (69%) patients had been through a previous laparotomy before the index hospitalization period and eighteen (69%)patients had at least one antecedent laparotomy done before laparostomy during the index period. 0–6 (mean 2) operations were performed during OA therapy before the first EAF diagnosis. 50% had negative pressure wound therapy (VACM) as TAC. The duration of OA treatment before EAF diagnosis varied from zero to 23 days (mean 7) and as a whole from five to 140 (mean 18) days. The length of hospitalization period varied from six to 87 (mean 29) days.

3.2. EAFs location and number

The twenty-six patients were diagnosed with altogether 56 EAFs. Thirteen (50%) patients were diagnosed with one and the rest (50%) with two to five (mean two) EAFs. More accurate location of the fistulae is described in Table A.2.

In 69% of cases the EAF was found at an anastomosis or at a serosal defect. 31% had their EAFs detected at a previously healthy bowel. (Table A.2)

3.3. OA and EAF-related supportive care

Twenty-one (81%) patients were admitted to the ICU during the index hospitalization period and stayed there for 5 to 56 (mean 24) days. Twenty-three (88%) patients were treated with total parenteral nutrition (TPN) and nine (35%) patients were administered octreotide in order to reduce the effluent volume. Sixteen (62%) patients received iv blood products. Vasoactive support was needed in 73% (19/26) of cases and temporary renal replacement therapy in 35% (9/26).

3.4. EAF repair

3.4.1. Surgery

Primary surgical repair of all diagnosed EAFs was chosen for twenty-three (88%) patients at the diagnosis of an EAF. All these OAs were classified as either 1C or 2C. Fourteen of these were managed with direct suturing of the fistulae. Eight patients underwent bowel resection and for five of these (5/8) also an ileo- or colostoma was prepared. One patient was managed by ileostomy only.

2/9 patients managed with resection/stoma died of MODS 1–2 days after EAF repair. Among the seven survivors a recurrent EAF was diagnosed in three cases (43%). In contrast, 12/14 (86%) patients in the group of direct suturing developed a recurrent EAF ($p = 0.04$).

Altogether fifteen recurrences were diagnosed after surgical EAF repair. Ten of these (33%) were managed operatively with a success rate of (6/10) 60%. (Fig. A.1.) 3/10 died: two due to relapsing EAFs and severe infections and one drifted into prolonged ICU-care,

impaired healing and perished. 1/10 developed a persistent EAF, which was later repaired in a reconstructive operation after 6 months.

Five (5/15) recurrences were treated conservatively. All these patients developed a persistent EAF and three (3/5) died because of that. (Fig. A.1) Both of the two survivors reached secondary reconstruction after 11 to 17 (mean 14) months.

Of all the twenty-three surgically treated patients fifteen (65%) survived. Of this group three (20%, 3/15) patients ended up with a persistent EAF, which were all reconstructed later. 9/15 patients reached abdominal closure and for the remaining 6/15 patients skin grafts were positioned to cover the viscera. These six patients included those three with persistent EAFs.

3.4.2. Conservative treatment

For three (3/26) patients a non-surgical approach was chosen primarily. (Fig. A.1) Two of these OAs were classified as grade 4 and one as grade 2C at the diagnosis of an EAF. Two patients had no specific treatment for their EAFs due to minimal leakage and uncertain location of the defect. One patient was treated with a percutaneous gastrostomy (PEG) system inserted intraluminally through the EAF and tightened against the abdominal wall.

One patient managed by follow-up died due to persistent infection of uncertain origin. The other was transferred to another hospital for further care with unknown outcome. The patient treated with PEG was left with a persistent EAF, but reached abdominal closure and was discharged. Later-on he went through an attempt of endoscopic closure but died shortly after that acutely of cardiac reasons.

3.5. TAC and EAF recurrence

In the group of the twenty-three surgically treated patients twelve (52%) had a plastic silo (Bogota bag) or surgical drapes as TAC and eleven (48%) were managed with VACM prior to the EAF diagnosis. In the latter group two patients died 1–2 days after EAF repair and were excluded from further analysis. 11/12 patients treated with Bogota bag or drapes developed a recurrent EAF whereas only 4/9 patients in the VACM-group did ($p = 0.02$).

In the group of the twenty-one early survivors after EAF repair, four (19%) patients reached fascial closure simultaneously with EAF repair. Two (2/4) of these developed a recurrent EAF: one after a newly established ACS and laparostomy and the other had an enteric leak via silicon tube drainage after fascial closure which thus actually represented an enterocutaneous fistula. The former patient was managed operatively by suturing and survived. The latter was treated conservatively and died of persistent fistula and MODS.

Of the rest, nine (9/17, 53%) had Bogota bag or drapes as TAC and ten (8/17, 47%) were treated with VAC/VACM. All the nine patients (100%) treated with non-negative pressure dressings developed a recurrent EAF whereas only 4/8 (50%) in the negative-pressure treated group were diagnosed with recurrence ($p < 0.02$).

3.6. Mortality

Altogether nine (35%) patients died during index hospitalization period due to OA related reasons. The causes of death were persistent EAF (four patients), other severe infective complications (two patients) and multi-organ-dysfunction-syndrome (MODS) (three patients). Six (23%) patients died with OA.

In the group of patients with OA duration under 7 days prior to the EAF the mortality was 3/15 (20%). Among those treated for OA over one week prior to the EAF, the mortality was 6/11 (55%), ($p = 0.067$).

4. Discussion

This study corroborates the previous conception of antecedent abdominal surgery predisposing to the development of complications during OA management. Furthermore, our patient population representing 70% peritonitis and 35% in-hospital mortality, well reflects other studies reporting overall worse outcome with higher mortality, increased complications and lower facial closure rates in secondary peritonitis compared to trauma treated with OA [15,20]. We observed resection or stoma preparation to be superior to plain suturing in effort to avoid EAF recurrence. Also topical negative-pressure solutions were shown preferable in comparison to non-negative dressings as TAC in order to avoid EAF relapse. In line with previous observations on the duration of OA management, we show a trend toward increased mortality after OA treatment longer than seven days prior to the EAF diagnosis.

Open abdomen (OA) management is of irreplaceable value when treating or preventing abdominal compartment syndrome (ACS) after trauma or damage control surgery [21,22]. Its role has recently grown in the management of severe peritonitis and it is increasingly used as a follow-up tool in cases of planned reoperations or in patients with compromised intestinal circulation [23,24]. Excluding trauma patients, the conditions leading to increased intra-abdominal pressure often associate with a critically fading general state of the patient and a need for long-lasting ICU care. This combination is a favorable platform for the development of various complications.

One of the most devastating complications in an open abdomen is a fistula between the bowel and the atmosphere (EAF). These appear especially in the course of prolonged OA treatment which predisposes to the development of intra-abdominal adhesions and finally frozen abdomen [7,25]. All manipulation of the fragile intra-abdominal contents, including TAC changes, is considered as a potential risk factor for iatrogenic bowel injury and thus an EAF [26]. In this study 77% of patients had gone through at least one laparotomy before laparostomy during the studied hospitalization period.

NPWT with continuous fascial traction has proven its role as an efficient means to reach primary fascial closure after OA [18,19,27–29]. Atema et al. further reported NPWT with fascial traction to have the lowest risk for EAF development in comparison to NPWT or mesh inlay alone. On the contrary, in 2010 recommendations were published in favor of choosing other TAC alternative than NPWT with mesh after damage control surgery to avoid the development of fistula [30]. In 2014 Bruhin et al. [8] concluded NPWT to be the best option currently available to treat Grade 3 OA with an EAF. In our population approximately 50% of patients had VAC/VACM as TAC both prior to and after EAF diagnosis and it associated with decreased EAF recurrence compared to non-negative pressure dressings.

The management of EAFs is difficult and laborious. EAFs are characterized by a lack of a real fistula tract and surrounding soft tissue which diminish the possibility of spontaneous healing [31,32]. Thus, surgical interventions are usually needed. After recognition of an EAF, the often hypercatabolic patient should first be stabilized with an aim at decreasing the fistula output and correcting the fluid imbalance [11]. Means to diminish the effluent include total parenteral nutrition, somatostatin analogs and proton pump inhibitors [33]. The second step in EAF management is classification and decision making on further treatment. Only after that the definitive surgery takes place [34]. DiSaverio et al. [35] have recently published an algorithm on surgical management. It takes into account the amount of fistula effluent, the number of fistulae and whether the patient suffers from ongoing peritonitis or not. Many treatment options have been described. The conventional strategies: suturing, bowel resection or proximal diversion are sometimes preceded or totally replaced by one of the many VAC-solutions. These are at times used in combination with biologic dressings in order to seal the fistula

opening and promote its closure [36]. We report a final success rate of 80% with surgical approach as first-line therapy among survivors. The conservative means resulted in EAF persistence in 100%.

EAFs are not only harmful for the patients and laborious for the surgeons but they also create a heavy financial burden for the society by increasing the ICU stay by three-fold, the hospital stay by four-fold and the hospital charges by four and a half-fold [37]. The onset of the vicious circle leading to a hostile abdomen should be prevented in time by prompt abdominal closure [38]. In case of an EAF diagnosis, effective control of the effluent volume and spillage followed by timely surgical management is recommended to avoid prolonged ICU treatment. EAF-related mortality is high, 30–60% according to the literature [39–42]. In our series, the incidence of EAF among OA patients during the studied time period was (30/229) 13%. 35% of patients died which is in line with previous reports considering our critically ill patient population.

5. Conclusions

The development of EAFs seems to be associated with a history of previous abdominal surgery. Primary resection of the affected region and preparation of a stoma appear to be the most successful approaches to avoid EAF recurrence. Furthermore, negative pressure wound therapy is significantly more efficient compared to non-negative-pressure solutions in relation to EAF recurrence. The length of the OA treatment seems to be associated with mortality.

Ethical approval

The institutional review board of hospital approved the protocol.

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Author contribution

The conception and design of the study: Ari Leppäniemi, Panu Mentula, Suvi Rasilainen.

Acquisition of data: Milla Viljanen, Suvi Rasilainen.

Analysis and interpretation of data: Milla Viljanen, Suvi Rasilainen.

Drafting the article: Suvi Rasilainen.

Critical revision of the article: Panu Mentula, Ari Leppäniemi, Milla Viljanen.

Final approval of submission: Ari Leppäniemi, Panu Mentula, Suvi Rasilainen, Milla Viljanen.

Conflict of interest statement

No conflicts of interest.

Guarantor

Ari Leppäniemi, MD PhD.

Research registration UIN

Research registry.

UIN: research registry1466.

Appendix

Table A.1
Patient characteristics, N = 26.

Age years (mean, range)	61 (36–80)
Sex ratio (male)	20 (77 %)
Diagnosis	
Peritonitis	18 (69%)
Aortic pathology (RAAA[a]/dissection)	6 (23%)
Trauma	1 (4%)
Other (paralytic ileus)	1 (4%)
Chronic illnesses	
Elevated blood pressure	15 (58%)
Obesity	9 (35%)
Dyslipidemia	6 (23%)
Alcoholism	6 (23%)
Asthma/COPD[b]	5 (19%)
Psychiatric condition	5 (19%)
Diabetes	4 (15%)
Coronary disease	4 (15%)
Active malignancy	3 (12%)
Colitis ulcerosa	3 (12%)
Arterial sclerosis	3 (12%)
Rheumatoid disease	2 (8%)
Cardiac failure	2 (8%)
Prostatic hyperplasia	2 (8%)
Chronic pancreatitis	1 (4%)
Renal failure and dialysis	1 (4%)
Epilepsy	1 (4%)

[a] RAAA = ruptured abdominal aortic aneurysm.
[b] COPD = chronic obstructive pulmonary disease.

Table A.2
Patient characteristics, N = 26.

Indication for laparostomy	
ACS[a]	7 (27%)
Inability to close the abdomen	8 (31%)
Prophylactic	11 (42%)
Classification of open abdomen	
1C	4 (15%)
2C	20 (77%)
4	2 (8%)
TAC[b] before EAF[c]	
Bogota bag/surgical drapes	13 (50%)
VACM	13 (50%)
TAC after EAF	
Bogota bag/surgical drapes	9 (47%)
VAC/VACM	10 (53%)
Open abdomen duration pre EAF	
0–7 days	15 (58%)
Over 7 days	11 (42%)
EAF location	
Normal intestine	8 (31%)
Anastomosis	14 (54%)
Serosal defect	4 (15%)
Small bowel	17 (65%)
Large bowel	3 (12%)
Gastric	1 (4%)
Small bowel + gastric	2 (8%)
Small bowel + large bowel	3 (12%)
Laparotomies at the index hospitalization period (before laparostomy)	
0	6 (23%)
1	15 (58%)
2 or more	5 (19%)
Previous laparotomies (before index period)	
0	8 (31%)
1	8 (31%)
2 or more	10 (38%)

[a] ACS = abdominal compartment syndrome.
[b] TAC = temporary abdominal closure.
[c] EAF = enteroatmospheric fistula.

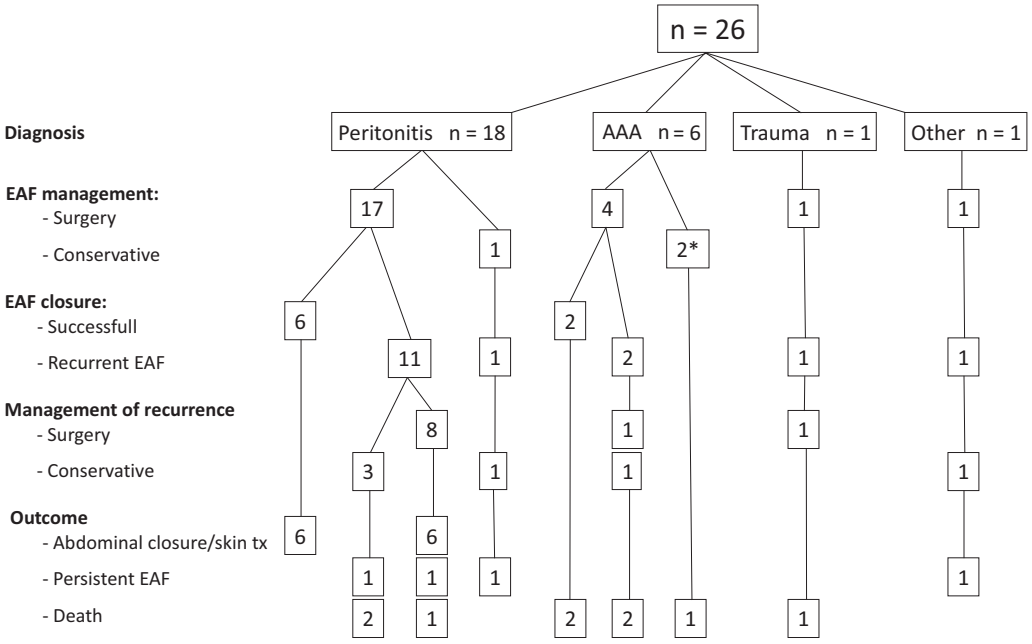

Fig. A.1. Management and outcome of EAFs. Numbers in the boxes represent the number of patients. *One patient was referred to another hospital for further follow-up.

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